Remarks: Claim Amendments

Amendments to the independent claims were made to better clarify the novel features of the invention over the prior art. Amendments to the dependent claims were made to recite the same terminology in the amended independent claims. In particular, the following changes were made:

In the Independent Claim 44, the clause:

"— phase offsetting (16n) each of the plurality of carrier signals wherein the phase offsets are incremental phase offsets —"

has been replaced with:

"— providing the carriers with at least one predetermined phase space (16n), each phase space mapping a data symbol to one of a plurality of pulse waveforms generated from a superposition of the carriers and centered at a predetermined instant in time, the pulse waveforms being positioned substantially orthogonally in time —"

Orthogonal pulses are described on page 3, lines 24-28, page 6, line 21 to page 7, line 4 of the retyped specification, and shown in Figures 4 and 12B. Each phase space is indicated by a set of incremental phase offsets $e^{in\Delta\phi_k}$ described on page 5, lines 28-31 and indicated by the phase term $e^{in\Delta\phi}$ inside the summation of the equation shown on page 6, line 34 and described on page 6, line 29 to page 7, line 26. Phase spaces are also described on page 3, lines 30-32 and page 8, lines 14-22.

In the amended Dependent Claim 45, the term "— the step of —" was removed to comply with the terminology used in the independent Claim 44. Similarly, the phrase "— phase offsetting (16n) the carriers —" was replaced by "— providing the carriers with at least one predetermined phase space (16n) —", as recited in the amended independent Claim 44.

In the amended Dependent Claim 46, the term "— the step of —" was removed to comply with the terminology used in the independent Claim 44. Similarly, the phrase "— phase offsetting (16n) the carriers —" was replaced by "— providing the carriers with at least one predetermined phase space (16n) —", as recited in the amended independent Claim 44. The phrase "— but on different groups of carriers —" was added to better clarify an inventive aspect of the technology wherein users employing different CIMA carriers may use the same phase space with respect to time without co-channel interference, such as recited on page 8, lines 17-19 of the retyped specification.

In the amended Dependent Claim 47, the term "— the step of —" was removed to comply with the terminology used in the independent Claim 44.

In the amended Dependent Claim 48, the term "— the step of —" was removed to comply with the terminology used in the independent Claim 44. A minor grammatical change was made in replacing "— being characterized by —" with "— provides for —".

In the amended Dependent Claim 49, the term "— the step of —" was removed to comply with the terminology used in the independent Claim 44.

In the amended Dependent Claim 50, the term "— the step of —" was removed to comply with the terminology used in the independent Claim 44.

In the amended Dependent Claim 51, the term "— the step of —" was removed to comply with the terminology used in the independent Claim 44. A minor grammatical change was made by replacing the phrase "— being characterized by a step of tapering a —" with "— includes providing the carriers with a tapered —". The phrase "— the step of combining (24) the modulated, phase-offset carrier signals being characterized by producing a transmitted CIMA signal having reduced time-domain side-lobe energy —" was removed.

In the amended Dependent Claim 52, the term "— the step of —" was removed to comply with the terminology used in the independent Claim 44.

In the amended Dependent Claim 53, the phrase "— the step of phase offsetting (16n) the carriers is performed to match—" was replaced with "— providing the carriers with at least one predetermined phase space (16n) matches —" to comply with the terminology used in the independent Claim 44.

In the amended Dependent Claim 54, the term "— the step of —" was removed to comply with the terminology used in the independent Claim 44.

Claims 55 and 56 are unchanged.

In the amended Dependent Claim 57, the term "— the steps of —" was removed to comply with the terminology used in the independent Claim 44.

Claim 58 is unchanged.

In the amended Dependent Claim 59, the phrase "— the step of phase offsetting (16n) —" was replaced with "— providing the carriers with at least one predetermined phase space (16n) —" to comply with the terminology used in the independent Claim 44.

In the amended Dependent Claim 60, the phrase "— the step of phase offsetting (16n) —" was replaced with "— providing the carriers with at least one predetermined phase space (16n) —" to comply with the terminology used in the independent Claim 44.

In the amended Dependent Claim 61, the phrase "— a step of identifying the users —" was deleted to remove an unnecessary step. The resulting claim is supported in the specification on page 9, lines 5-9 of the retyped specification. The phrase "— user

that is used —" was replaced with "— of a plurality of users —" as a minor grammatical correction.

In the Independent Claim 62, the following clause was added:
"— providing phase-space compensation to the carrier signal components (60mn), each phase space corresponding to a data symbol mapped onto one of a plurality of pulse waveforms generated from a superposition of carriers and centered at a predetermined instant in time, the pulse waveforms being positioned substantially orthogonally in time —"

Phase-space compensation (60mn) is described on page 7, lines 32-34. Phase spaces are indicated by a set of incremental phase offsets $e^{in\Delta\phi_k}$ described on page 5, lines 28-31 and indicated by the phase term $e^{in\Delta\phi}$ inside the summation of the equation shown on page 6, line 34 and described on page 6, line 29 to page 7, line 26. Phase spaces are also described on page 3, lines 30-32 and page 8, lines 14-22.

In the amended Dependent Claim 63, the phrase "— the step of combining (62m) the multi-frequency carrier-signal components —" was replaced with "— providing phase-space compensation to the carriers —" in accordance with the amendment to independent Claim 62.

In the amended Dependent Claim 64, the term "— the step of —" was removed to comply with the terminology used in the independent Claim 62. The phrase "— providing (60mn) at least one set of predetermined delays to each set of received carrier-signal components to compensate for relative phases between the carriers in order to combine the carrier signals in phase —" was replaced with "— providing channel compensation to the multi-frequency carrier-signal components —", which is supported throughout the specification, such as on page 5, line 33-34 and page 7, line 30-31.

In the amended Dependent Claim 65, the term "— the steps of —" was removed to comply with the terminology used in the dependent Claim 64.

In the amended Dependent Claim 66, the term "— the steps of —" was removed to comply with the terminology used in the independent Claim 62.

In the Independent Claim 67, the clause:

"—phase offsetting (16n) each of the plurality of carrier signals wherein the phase offsets are incremental phase offsets —"

has been replaced with:

"— providing the carriers with at least one predetermined phase space (16n), each phase space mapping a data symbol to one of a plurality of pulse waveforms generated from a superposition of the carriers and centered at a predetermined instant in time, the pulse waveforms being positioned substantially orthogonally in time —"

"Providing the carriers with at least one predetermined phase space (16n)" is supported throughout the specification, such as on page 5, lines 29-31. Phase-space compensation (60mn) is described on page 7, lines 32-34. Phase spaces are indicated by a set of incremental phase offsets $e^{in\Delta\phi}{}_k$ described on page 5, lines 28-31 and indicated by the phase term $e^{in\Delta\phi}$ inside the summation of the equation shown on page 6, line 34 and described on page 6, line 29 to page 7, line 26. Phase spaces are also described on page 3, lines 30-32 and page 8, lines 14-22.

In the Independent Claim 68, the clause:

"—a delay controller (16n) capable of applying a plurality of incremental phase offsets to the carrier signals for providing the carrier signals with a predetermined phase space at a predetermined time interval —"

has been replaced with:

"— a phase-space controller (16n) adapted to provide the carriers with at least one predetermined phase space, each phase space mapping a data symbol to one of a plurality

of pulse waveforms generated from a superposition of the carriers and centered at a predetermined instant in time, the pulse waveforms being positioned substantially orthogonally in time —"

The term "delay controller" has been replaced with "phase-space controller" based on the original disclosure, such as on page 3, lines 30-31, "phase space is defined as a time (phase) offset between the carriers. The offset enables the pulse to be observed in a specific time interval." Descriptions of how phase spaces relate to pulse waveforms is described throughout the specification, such as on page 3, lines 24-26, "the frequency and phase of each carrier is selected so that the superposition of the signals results in a pulse (constructive interference resulting from a zero-phase relationship between the carriers) that occurs in a specific time interval."

Dependent Claim 69 is unchanged.

In dependent Claim 70, "— transmits —" was replaced with "— is adapted to transmit —".

In dependent Claim 71, "— transmits —" was replaced with "— is adapted to transmit —".

Dependent Claims 72 and 73 were unchanged.

Dependent Claim 74 was amended to recite the phase-space controller that is recited in Claim 68.

In dependent Claim 75, the phrase "— are non-uniformly separated in frequency —" was replaced with "— have uniform, but non-adjacent frequency spacing —", which is supported in the specification, such as on page 8, lines 28-33.

In dependent Claim 76, a minor grammatical change was made. In particular, the phrase "— for providing —" was replaced with "— adapted to provide —".

In dependent Claim 77, minor grammatical changes were made. In particular, the word "— applies —" was replaced with "— is adapted to apply —" and the word "— combines —" was replaced with "— is adapted to combine —".

In dependent Claim 78, minor grammatical changes were made. In particular, the word "— combines —" was replaced with "— is adapted to combine —" and the phrase "— that occupy at least one nonzero phase space —" was deleted.

In dependent Claim 79, minor grammatical changes were made. In particular, the word "— combines —" was replaced with "— is adapted to combine —" and the phrase "— CIMA signals that combine destructively in a zero-phase space —" was replaced with "— at least one CIMA signal whose carriers combine destructively in a zero-phase space of at least one other CIMA signal —".

Dependent Claim 80 was amended to recite the phase-space controller that is recited in Claim 68. A minor grammatical change was made wherein the word "— provides —" was replaced with "— is adapted to provide —".

Dependent Claim 81 was amended to recite the phase-space controller that is recited in Claim 68. A minor grammatical change was made wherein the word "— provides —" was replaced with "— is adapted to provide —".

In the Independent Claim 82, the phrase:

"— multicarrier signals characterized by information modulated onto at least one phase space —"

was inserted, and the function of the combiner (62mn) was changed to

"— combining the plurality of received multi-frequency carrier-signal components <u>with respect to the at least one phase space</u> —".

Descriptions of how carrier signals are combined to produce pulse waveforms are supported throughout the specification, such as on page 7, lines 33-34 and on page 6, line 29 to page 7, line 8. FIG. 4 illustrates phase relationships and phase spaces resulting from a superposition of carrier signals.

In the Dependent Claim 83, the following phrase was inserted:
"— a phase-space compensator (60mn) adapted to phase shift the carriers relative to at least one phase space, each phase space corresponding to a data symbol mapped onto one of a plurality of pulse waveforms generated from a superposition of the carriers and centered at a predetermined instant in time, the pulse waveforms being positioned substantially orthogonally in time —".

Phase-space compensation (60mn) is described on page 7, lines 32-34. Phase spaces are indicated by a set of incremental phase offsets $e^{in\Delta\phi}{}_k$ described on page 5, lines 28-31 and indicated by the phase term $e^{in\Delta\phi}$ inside the summation of the equation shown on page 6, line 34 and described on page 6, line 29 to page 7, line 26. Phase spaces are also described on page 3, lines 30-32 and page 8, lines 14-22.

Dependent Claim 84 was amended to recite the phase-space controller that is recited in Claim 83. A minor grammatical change was made wherein the word "— is —" was replaced with "— includes —".

Dependent Claim 85 was amended to recite the phase-space controller that is recited in Claim 83. A minor grammatical change was made wherein the word "— samples —" was replaced with "— is adapted to sample —".

In dependent Claim 86, a minor grammatical change was made wherein the phrase "— that estimates —" was replaced with "— adapted to estimate —".

In dependent Claim 87, minor grammatical changes were made wherein the phrase "— that samples —" was replaced with "— adapted to sample —", the word "— weights —" was replaced with "— weight —", and the word "— combines —" was replaced with "— combine —".

In dependent Claim 88, a minor grammatical change was made wherein the word "— provides —" was replaced with "— is adapted to provide —".

In the Independênt Claim 89, the phrase:

"— a delay controller (16n) capable of applying a plurality of incremental phase offsets to the carrier signals for providing the carrier signals with a predetermined phase space at a predetermined time interval —"

was replaced with

"— a phase-space controller (16n) adapted to provide the carriers with at least one predetermined phase space, each phase space mapping a data symbol to one of a plurality of pulse waveforms generated from a superposition of the carriers and centered at a predetermined instant in time, the pulse waveforms being positioned substantially orthogonally in time —"

The term "delay controller" has been replaced with "phase-space controller" based on the original disclosure, such as on page 3, lines 30-31, "phase space is defined as a time (phase) offset between the carriers. The offset enables the pulse to be observed in a specific time interval." Phase spaces are described throughout the specification with respect to how they relate to pulse waveforms, such as on page 3, lines 24-26, "the frequency and phase of each carrier is selected so that the superposition of the signals results in a pulse (constructive interference resulting from a zero-phase relationship between the carriers) that occurs in a specific time interval."

In the Independent Claim 89, the phrase:

"— phase offsetting (16n) the carrier signals to generate a predetermined time-domain profile for a superposition of the carrier signals—"

was replaced with

"— providing the carrier signals with at least one predetermined phase space (16n), each phase space corresponding to at least one pulse waveform generated from a superposition of the carriers and centered at a predetermined instant in time —"

and the phrase:

"— providing (18n) a gain profile to the carrier signals to provide the at least one predetermined time-domain characteristic to the superposition of the carrier signals —"

was replaced with:

"— providing at least one predetermined gain profile to the carrier signals (18n) to shape the at least one pulse waveform —".

Each phase space is indicated by a set of incremental phase offsets $e^{in\Delta\phi_k}$ described on page 5, lines 28-31 of the retyped specification and indicated by the phase term $e^{in\Delta\phi}$ inside the summation of the equation shown on page 6, line 34 and described on page 6, line 29 to page 7, line 26. Phase spaces are also described on page 3, lines 30-32 and page 8, lines 14-22. Phase spaces are described throughout the specification with respect to how they relate to pulse waveforms, such as on page 3, lines 24-26, "the frequency and phase of each carrier is selected so that the superposition of the signals results in a pulse (constructive interference resulting from a zero-phase relationship between the carriers) that occurs in a specific time interval."

In the Independent Claim 90, the phrase:

"— phase offsetting (16n) the carrier signals to generate a predetermined time-domain profile for a superposition of the carrier signals—"

was replaced with

"— providing the carrier signals with at least one predetermined phase space (16n), each phase space corresponding to at least one pulse waveform generated from a superposition of the carriers and centered at a predetermined instant in time —",

the phrase:

"— providing (18n) a gain profile to the carrier signals to provide the at least one predetermined time-domain characteristic to the superposition of the carrier signals —"

was replaced with:

"— providing at least one predetermined gain profile to the carrier signals (18n) to shape the at least one pulse waveform —",

and the phrase:

"— combining (20) the modulated, phase-offset carrier signals to generate the superposition of the carrier signals having the at least one predetermined time-domain characteristic —"

was replaced with

"— combining (20) the carrier signals to generate the at least one pulse waveform having the at least one predetermined time-domain characteristic —"

In the original disclosure, as indicated in the retyped specification, each phase space is indicated by a set of incremental phase offsets $e^{in\Delta\phi}{}_k$ described on page 5, lines 28-31 of the retyped specification and indicated by the phase term $e^{in\Delta\phi}$ inside the summation of the equation shown on page 6, line 34 and described on page 6, line 29 to page 7, line 26. Phase spaces are also described on page 3, lines 30-32 and page 8, lines 14-22. Phase spaces are described throughout the specification with respect to how they relate to pulse waveforms, such as on page 3, lines 24-26, "the frequency and phase of each carrier is selected so that the superposition of the signals results in a pulse (constructive interference resulting from a zero-phase relationship between the carriers) that occurs in a specific time interval."

In dependent Claim 91, grammatical and other minor changes were made in accordance with amended terminology in Claim 90. In particular, the phrase:

"— phase offsetting —"

was replaced with

"— providing the carrier signals with at least one predetermined phase space —",

the phrase:

"— providing the gain profile —"

was replaced with

"— providing at least one predetermined gain profile to the carrier signals —",

and the word "— generates —" was replaced with "— is adapted to generate —".

Changes to dependent Claim 92 were made to comply with amended terminology in Claim 90. In particular, the phrase:

"— providing the gain profile —"

was replaced with

"— providing at least one predetermined gain profile —",

and the phrase "— the step of — " was deleted.

In the independent Claim 93, the term "— delay controller —" was replaced with "— phase-space controller —".

The term "delay controller" was replaced with "phase-space controller" based on the original disclosure, such as on page 3, lines 30-31 of the retyped specification, "phase space is defined as a time (phase) offset between the carriers. The offset enables the pulse to be observed in a specific time interval." Phase spaces are described throughout the specification with respect to how they relate to pulse waveforms, such as on page 3, lines 24-26, "the frequency and phase of each carrier is selected so that the superposition of the signals results in a pulse (constructive interference resulting from a zero-phase relationship between the carriers) that occurs in a specific time interval."

In dependent Claim 94, the term "— delay controller —" was replaced with "— phase-space controller —" in accordance with the amended independent Claim 93. In a minor grammatical change, the phrase "— are adapted to —" was inserted.

In independent Claim 95, the original phrase "— the frequency division multiplexed signal —" was replaced with "— the plurality of carriers —" because the original phrase lacked a proper antecedent basis.

In independent Claim 96, the phrase "— at least one —" was inserted to provide for a proper antecedent basis.

Independent Claim 97 is unchanged.

In independent Claim 98, the phrase:

"— to produce at least one signal indicative of a modulated pulse waveform —"

was inserted, and the phrase:

"— combined carriers —"

was replaced with

"— at least one signal indicative of the modulated pulse waveform —".

Modulation of the carriers, and thus, the pulse waveforms, is described throughout the specification, such as on page 5, lines 18-21 of the retyped specification. On page 6, lines 17-28, modulation and pulse generation are described.

In independent Claim 99, the phrase:

"— to generate at least one signal indicative of a modulated pulse waveform —"

was inserted, and the phrase:

"— combined carriers —"

was replaced with

"— at least one signal indicative of the modulated pulse waveform —".

Modulation of the carriers, and thus, the pulse waveforms, is described throughout the specification, such as on page 5, lines 18-21 of the retyped specification. Modulation and pulse generation are described on page 6, lines 17-28.

In independent Claim 100, a minor grammatical error was corrected. In particular, the phrase "— a plurality carriers —" was changed to "—a plurality of carriers —".

Claims 101 to 109 are unchanged.

In Claim 110, a minor grammatical error was corrected. In particular, on the first line, the word "— to —" was added after "— adapted —".

Claim 111 is unchanged

Dependent Claims 112 to 136 are new claims that were added to recite the implementation of frequency hopping in Carrier Interferometry signaling described throughout the specification, such as on page 7, lines 6-10, and on page 8, lines 19-22.

The amendments made to the independent claims more specifically recite the features of the CIMA protocol utilized by the present invention.

Remarks: Examination Report

It is submitted that with the amended claims herein, the objections raised against the claims are overcome.

1. ***Section 1 of the Examination Report***

Claims 44-94, 102, 103, 107-109, and 111 were rejected under 35 U.S.C. 102(b) as being anticipated by Hershey (U.S. Pat. No. 5,563,906).

2. Applicant submits that the above-recited step of providing the carriers with at least one predetermined phase space in the amended independent claims 44, 67, and 90 (and hence, in the dependent claims 45-61, 91, 92, 112, 114, and 118) clearly presents novel methods that the prior-art references neither describe nor anticipate. Thus, the amended independent claims 44, 67, and 90, (and hence, the dependent claims 45-61, 91, 92, 112, 114, and 118) should be considered patentable under 35 U.S.C. 102.

3. Applicant submits that the above-recited phase-space controller in the amended independent claims 68, 89, and 93 (and hence, in the dependent claims 69-81, 94, 115, 117, and 119) clearly presents novel structure that the prior-art references neither describe nor anticipate. Thus, the amended independent claims 68, 89, and 93 (and hence, the dependent claims 69-81, 94, 115, 117, and 119) should be considered patentable under 35 U.S.C. 102.

4. Applicant submits that the above-recited step of providing phase-space compensation to the carrier-signal components in the amended independent claim 62 (and hence, in the dependent claims 63-66) clearly presents a novel method that the prior-art references neither describe nor anticipate. Thus, the amended independent claim 62, (and hence, the dependent claims 63-66) should be considered patentable under 35 U.S.C. 102.

5. Applicant submits that the above-recited combiner in the amended independent claim 82 (and hence, in the dependent claims 83-88, and 116) clearly presents novel structure that the prior-art references neither describe nor anticipate. Thus, the amended independent claim 82 (and hence, the dependent claims 83-88, and 116) should be considered patentable under 35 U.S.C. 102.

6. Applicant submits that the above-recited step of generating a superposition signal by applying a pulse function in the independent claims 102 and 103 (and hence, in the dependent claims 127 and 128) clearly presents novel methods that the prior-art references neither describe nor anticipate. Thus, the independent claims 102 and 103 (and hence, the dependent claims 127 and 128) should be considered patentable under 35 U.S.C. 102.

7. Applicant submits that the above-recited pulse-generation circuit in the independent claim 107 (and hence, in the dependent claim 132) clearly presents novel structure that the prior-art references neither describe nor anticipate. Thus, the independent claim 107 (and hence, the dependent claim 132) should be considered patentable under 35 U.S.C. 102.

8. Applicant submits that the above-recited pulse generator in the independent claims 108 and 109 (and hence, in the dependent claims 133 and 134) clearly presents novel structure that the prior-art references neither describe nor anticipate. Thus, the independent claims 108 and 109 (and hence, the dependent claims 133 and 134) should be considered patentable under 35 U.S.C. 102.

9. Applicant submits that the above-recited data source in the independent claim 111 (and hence, in the dependent claim 136) clearly presents novel structure that the prior-art references neither describe nor anticipate. Thus, the independent claim 111 (and hence, the dependent claim 136) should be considered patentable under 35 U.S.C. 102.

10. Specifically, the claimed invention purposely uses interfering carriers to generate pulse waveforms that are localized in time. In particular, the step of providing the carriers with at least one predetermined phase space in the amended independent claims 44, 67, and 90 maps each data symbol to one of a plurality of pulse waveforms generated from a superposition of the carriers and centered at a predetermined instant in time. The pulse waveforms are positioned orthogonally in time. Similarly, the phase-space controller recited in the amended independent claims 68, 89, and 93 provides the carriers with at least one predetermined phase space wherein each phase space maps a data symbol to one of a plurality of pulse waveforms generated from a superposition of the carriers and centered at a predetermined instant in time. The pulse waveforms are positioned orthogonally in time. The step of providing phase-space compensation to the carrier-signal components recited in the amended independent claim 62 processes phase spaces of the carrier-signal components wherein the phase spaces map data symbols to pulse waveforms generated from superpositions of the carrier-signal components. The pulse waveforms are positioned orthogonally in time. The combiner recited in the amended independent claim 82 combines the carriers with respect to at least one phase space to produce at least one constructive interference signal (i.e., pulse) indicative of at least one information signal. The step of generating a superposition signal that is recited in the independent claims 102 and 103 provides a pulse function characterized by a predetermined set of sinusoids. The pulse-generation circuit recited in the independent claim 107 produces a pulse sequence with a spectrum characterized by sinusoids having non-zero values at frequencies within a predetermined allocated carrier set. The pulse generator recited in the independent claims 108 and 109 generates a pulse train having a frequency response characterized by sinusoids with frequencies corresponding to a predetermined allocated carrier set. The data source recited in Claim 111 provides carriers with a predetermined set of phase relationships and amplitude profiles to produce a superposition of the carriers with orthogonality in time (i.e., the superpositions are pulse waveforms).

11. By providing the carriers of a multicarrier signal with at least one predetermined phase space, Applicant's invention spreads each data symbol over multiple carriers, thus providing superior frequency diversity. Furthermore, the phase spaces cause superpositions of the carriers to produce pulse waveforms, which provide orthogonality in time. This enables multiple data symbols and/or users to share the same frequencies, thus providing combined, and typically contradictory, benefits of frequency diversity and bandwidth efficiency. No other prior-art reference uses phase spaces nor produces pulse waveforms from superpositions of carriers. No other prior-art reference maps data symbols to pulse waveforms generated from multiple sinusoids. No other prior-art reference combines carriers in a way that produces signals that are orthogonal in time. Accordingly, no other prior-art reference processes received multicarrier signals with phase spaces that map data symbols to pulse waveforms generated from superpositions of carrier-signal components.

12. By applying a pulse function to a plurality of information symbols wherein the pulse function is characterized by a plurality of carriers (e.g., sinusoids), Applicant's invention spreads each data symbol over multiple carriers, thus providing superior frequency diversity. Since the pulse waveforms are localized in time, they can be positioned orthogonally in time. This enables multiple data symbols and/or users to share the same frequencies, thus providing combined, and typically contradictory, benefits of frequency diversity and bandwidth efficiency. No other prior-art reference combines carriers in a way that produces signals that are orthogonal in time. No other prior-art reference maps data symbols to pulse waveforms generated from multiple sinusoids.

13. **None of the prior-art references teach to generate pulse waveforms from superpositions of carrier signals. None of the prior-art references teach to combine carriers in a way that produces pulses that are orthogonal in time. None of the prior-art references teach to encode a multicarrier signal with phase spaces that map data symbols to pulse waveforms generated from carrier superpositions.**

Hershey describes geometric harmonic modulation (GHM) in which preamble and traffic waveforms are created from multiple carrier frequencies (i.e., tones) that are geometric harmonics of a fundamental tone. The waveforms of a GHM protocol incorporate binary phase spreading codes, rather than polyphase phase spaces, which are applied to the tones. The preamble waveforms of such a protocol are characterized by the features that they:

1. Do not carry data.
2. Do not generate pulse waveforms, such as orthogonal sinc pulses.
3. Employ binary-phase codes ('906, col. 5, lines 50-57), which are incapable of generating CIMA pulse waveforms.

The waveforms in Hershey are generated from binary-phase codes applied to the carriers, which produce waveforms that are not orthogonal to each other in the time domain.

The traffic waveforms constituent of Hershey's GHM are characterized by the features that they are:

1. Products, rather than sums of the binary phase coded tones ('906, col. 6, lines 15-18).
2. Not orthogonal. Rather, they are pseudo-orthogonal. The amount of interference between users increases linearly with respect to the number of users ('906, col.3 lines 31-34). Thus, even when the tones are phase aligned, such as illustrated in FIGs. 1a, 1b, and 1c in '906, the resulting waveforms are not orthogonal pulse waveforms.
3. Employ binary phase codes. Thus, GHM cannot provide carriers with phase relationships (e.g., phase spaces) that enable precise time-domain control of the carrier superpositions, such as to produce orthogonal pulses.

Accordingly, GHM is not capable of expressing orthogonality in the time domain, such as by generating pulse waveforms. Similarly, GHM is not capable of generating

waveforms that are backwards compatible with single-carrier protocols (such as DS-CDMA) or even other multi-carrier protocols.

Unlike the claimed invention, prior-art techniques (such as Hershey):

1. Do not incorporate phase spaces (i.e., orthogonal polyphase code values) on the tones.
2. Are not characterized by tone superpositions (sums) that produce pulse waveforms.
3. Do not map data symbols to pulse waveforms generated from multiple carriers and positioned at predetermined times.
4. Do not achieve orthogonality in the time domain via interferometry of the phase-coded multi-carrier signals.

It will be appreciated therefore that the schema described by the cited art is not the same as that claimed by the present invention. The present claims are therefore novel.

14. The claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

15. As detailed above, the cited art describes a different type of communication protocol to that claimed by the present invention. Although different to the present invention, such protocols have use, as is evidenced by the teaching of the prior art. Such use is served by the GHM protocol and there is no teaching in the prior art to change the type of communication protocol provided so as to resemble or reflect that of the present invention. As there is no motivation to change, no teaching to change, and no description of how any change may be made to produce a CIMA protocol, it is submitted that the presently claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

16. Section 2 of the Examination Report

In section 2, the Examiner cites Kobayashi (U.S. Pat. No. 4,912,422) in a rejection of Claims 95, 96, 100, and 101 under 35 U.S.C. 102(b).

17. Applicant submits that the above-recited steps of performing a frequency domain to time domain transform operation on the filtered frequency-domain signal to generate a filtered **time-domain signal** and recovering symbols transmitted to the at least one user from the filtered time-domain signal in independent claim 95 (and hence, in the dependent claim 120) clearly presents novel methods for processing a **multi-carrier** signal that the prior-art references neither describe nor anticipate. Thus, the independent claim 95 (and hence, the dependent claim 120) should be considered patentable under 35 U.S.C. 102.

18. Applicant submits that the above-recited step of providing for mapping values of the multicarrier signal at **instants in time** used to transmit symbol values in independent claim 96 (and hence, in the dependent claim 121) clearly presents novel methods for processing a **multi-carrier** signal that the prior-art references neither describe nor anticipate. Thus, the independent claim 96 (and hence, the dependent claim 121) should be considered patentable under 35 U.S.C. 102.

19. Applicant submits that the above-recited frequency to time domain transform module adapted to perform a frequency domain to time domain transform operation on the filtered frequency-domain signal to thereby generate a **time-domain** signal; and a decision module for mapping received signal values at points in time to estimated symbol values in independent claim 100 (and hence, in the dependent claim 125) clearly presents novel structure for processing a **plurality of carriers** that the prior-art references neither describe nor anticipate. Thus, the independent claim 100 (and hence, the dependent claim 125) should be considered patentable under 35 U.S.C. 102.

20. Applicant submits that the above-recited decision module adapted to map values of the multicarrier signal at **instants in time** used to transmit symbol values in

independent claim 101 (and hence, in the dependent claim 126) clearly presents novel structure for processing a **multi- carrier** signal that the prior-art references neither describe nor anticipate. Thus, the independent claim 101 (and hence, the dependent claim 126) should be considered patentable under 35 U.S.C. 102.

21. Specifically, the claimed invention performs a frequency domain to time domain transform of a **multicarrier** signal (i.e., a plurality of carriers) to produce a signal having **time-domain** characteristics indicative of **data symbols mapped to instants in time**. By providing for a frequency domain to time domain transformation, the claimed invention efficiently recovers data modulated onto phase spaces of a multicarrier signal. No other prior-art reference uses phase spaces, which map data symbols to instants in time. Thus, providing for a frequency domain to time domain transformation of a multicarrier signal is not taught in the prior art because it is impractical to process prior-art multicarrier signals in that manner.

22. **None of the prior-art references teach to perform a frequency domain to time domain transform of a multicarrier signal (i.e., a plurality of carriers). None of the prior-art references teach to transform a multicarrier signal (i.e., a plurality of carriers) into a signal having time-domain characteristics indicative of data symbols mapped to instants in time.**

This is because only signals generated via Carrier Interferometry produce highly orthogonal, data-bearing pulses in the time domain. Prior-art multicarrier signals, such as shown in Hershey, modulate different data symbols on each carrier or spread data across carriers with spreading codes that do not support orthogonality in the time domain.

Kobayashi teaches time domain to frequency domain processing for a **single-carrier** signal, followed by frequency domain to time domain processing. Kobayashi does not disclose any method for processing a **multi-carrier** signal in this manner.

The prior art does not suggest any combination or application of Kobayashi with multicarrier signals. The nature of prior-art multicarrier signals makes it impractical to apply Kobayashi to multicarrier processing. This is because in prior-art multicarrier signals, data symbols are not mapped to instants in time. Superposition pulses resulting from prior-art multicarrier signals comprise interfering data symbols at instants in time, such as illustrated and described in Applicant's U.S. Pat. No. 5,955,992, of which the present application is a Continuation in Part. Thus, it would not be appropriate to process prior-art multicarrier signals in the time domain, such as in the manner that single-carrier signals are processed in Kobayashi. Conversely, Carrier Interferometry pulses are interferometric superpositions of carriers with data symbols mapped to orthogonal phase spaces (i.e., pulse positions).

23. The claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

24. As detailed above, the cited art describes a type of single-carrier processing that is not practical if it were used to process prior-art multicarrier signals. The prior art does not teach to apply the method and apparatus disclosed in Kobayashi to multicarrier signals due to the fact that such processing lacks utility when applied to prior-art multicarrier signals. In particular, the application of frequency-domain-to-time-domain conversion to prior-art multicarrier signals results in unmanageable interference due to the inability of prior-art multicarrier signaling to provide orthogonality between data symbols in the time domain. Therefore, the application of Kobayashi to multicarrier processing would not be obvious to a person having ordinary skill in the art. Therefore, the claimed invention is non-obvious, making the claims patentable under U.S.C. 103.

25. Section 3 of the Examination Report

Claims 97-99 to 104-106 were rejected under 35 U.S.C. 102(e) as being anticipated by Liedenbaum (U.S. Pat. No. 5,691,832).

26. Applicant submits that the above-recited steps of generating at least one **pulse waveform** from a superposition of carriers and estimating at least one information **symbol impressed on the at least one pulse waveform** in independent claim 97 (and hence, in the dependent claim 122) clearly presents novel a method for processing a multi-carrier signal that the prior-art references neither describe nor anticipate. Thus, the independent claim 97 (and hence, the dependent claim 122) should be considered patentable under 35 U.S.C. 102.

27. Applicant submits that the above-recited combiner adapted to combine the carriers to produce at least one signal indicative of a **modulated pulse waveform** and the decision device adapted to generate at least one estimated data symbol from the at least one modulated pulse waveform in independent claims 98 and 99 (and hence, in the dependent claims 123 and 124) clearly presents novel structure for processing a multi-carrier signal that the prior-art references neither describe nor anticipate. Thus, the independent claims 98 and 99 (and hence, the dependent claims 123 and 124) should be considered patentable under 35 U.S.C. 102.

28. Applicant submits that the above-recited steps of generating at least one **pulse waveform** from a superposition of selected carriers and **impressing at least one information symbol on the at least one pulse waveform** in independent claim 104 (and hence, in the dependent claim 129) clearly presents novel method for generating a multi-carrier signal that the prior-art references neither describe nor anticipate. Thus, the independent claim 104 (and hence, the dependent claim 129) should be considered patentable under 35 U.S.C. 102.

29. Applicant submits that the above-recited pulse generator adapted to produce at least one **pulse waveform** from a superposition of selected carriers and the modulator adapted to accept at least one information symbol and **impress the at least one information symbol onto the at least one pulse waveform** in independent claim 105 (and hence, in the dependent claim 130) clearly presents novel structure for generating a multi-carrier signal that the prior-art references neither describe nor

anticipate. Thus, the independent claim 105 (and hence, the dependent claim 130) should be considered patentable under 35 U.S.C. 102.

30. Applicant submits that the above-recited pulse generator adapted to produce at least one **pulse waveform** having a plurality of carrier components and the modulator adapted to accept at least one information symbol and **impress the at least one information symbol onto the at least one pulse waveform** in independent claim 106 (and hence, in the dependent claim 131) clearly presents novel structure for generating a multi-carrier signal that the prior-art references neither describe nor anticipate. Thus, the independent claim 106 (and hence, the dependent claim 131) should be considered patentable under 35 U.S.C. 102.

31. Each of the Claims 97-99 and 104-106 recites a method or apparatus for generating or receiving Carrier Interferometry signals, which are characterized by **each** data symbol being modulated onto a **plurality** of carriers. Specifically, the claimed invention generates at least one pulse waveform characterized by carrier components of a multicarrier signal and modulates information onto the pulse waveforms. By modulating information onto these pulse waveforms, **each** data symbol is modulated onto a **plurality** of carriers. By providing modulated pulse waveforms having predetermined carrier components, the claimed invention efficiently generates and processes multicarrier signals with the combined advantages of redundant modulation over multiple carriers and orthogonality (represented by pulse waveforms in the time domain) between different information symbols. No other prior-art reference produces pulse waveforms having carrier components. No other prior-art reference modulates information onto pulse waveforms characterized by a predetermined set of carrier components.

32. **None of the prior-art references teach to purposefully generate pulse waveforms from superpositions of individual carrier components of a multicarrier signal. None of the prior-art references teach to provide for impressing information onto the pulse waveforms generated from the multicarrier signal.**

Liedenbaum describes a frequency-division multiplexed signal wherein "each signal to be transmitted is individually modulated on its own carrier" (col. 1, lines 44-45). That is, each data symbol is modulated onto only **one** carrier. A sum signal is produced by combining the modulated carriers. Since each data symbol is modulated onto only one carrier, **the sum signal (i.e., carrier superposition) does not produce pulse waveforms wherein each data symbol is modulated onto its own pulse.** Thus, Liedenbaum does not describe generating at least one pulse waveform from a combining (i.e., superposition) of carriers (such as recited in Claims 97-99, 104, and 105). Liedenbaum does not describe a pulse generator adapted to produce at least one pulse waveform having a plurality of carrier components, such as recited in Claim 106. Liedenbaum does not mention impressing information symbols onto the pulse waveforms, such as recited in Claims 104-106. Similarly, Liedenbaum does not mention estimating any information symbols impressed on the pulse waveforms, such as recited in Claims 97-99. Neither Liedenbaum, nor any of the other prior-art reference, recites a combiner that combines carriers to produce modulated pulse waveforms, such as recited in Claims 98 and 99. Rather, Liedenbaum merely modulates different information pulses onto each carrier at a transmitter and recovers the information by separating (rather than combining) the carriers at a receiver.

None of the prior-art references describe this functionality because this functionality is not possible unless a Carrier Interferometry signal is employed. Accordingly, apparatus components associated with the above-recited functionality are not practical unless a Carrier Interferometry signal is employed.

33. **The claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.**

34. As detailed above, the cited art describes information pulses, each modulated onto its own carrier. The carriers are summed to produce a combined signal. However, since each data symbol is modulated onto its own carrier, the carriers do not combine to

produce pulse waveforms wherein each data symbol is modulated onto its own pulse. Rather, a carrier superposition will consist of a pseudo-random overlapping of modulated carriers in which information can be recovered only by separating the carriers. In applications such as described in Liedenbaum, **the prior art typically teaches against modulating each data symbol onto multiple carriers** because such practice constitutes an inefficient use of bandwidth. Consequently, the prior art fails to teach modulating each data symbol onto its own pulse resulting from a superposition of carriers.

Since the claimed invention produces orthogonal data-modulated pulses from multicarrier signals, which no prior-art references nor combination of prior-art references disclose, new and unexpected benefits are created, making the claimed invention non-obvious. In particular, reduced complexity of multicarrier receiver designs are enabled, backwards compatibility with existing single-carrier signals is possible, and simultaneous benefits of optimal bandwidth efficiency and frequency diversity are achieved, which greatly improves performance.

The cited art describes a different type of communication protocol to that claimed by the present invention. Although different to the present invention, such protocols have use, as is evidenced by the teaching of the prior art. Such use is served by the Liedenbaum protocol and there is no teaching in the prior art to change the type of communication protocol provided so as to resemble or reflect that of the present invention. As there is no motivation to change, no teaching to change, and no description of how any change may be made to produce a CIMA protocol, it is submitted that the presently claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

35. Section 4 of the Examination Report

Claim 110 was rejected under 35 U.S.C. 103(a) as being unpatentable over Hershey (U.S. Pat. No. 5,563,906) in view of Kobayashi (U.S. Pat. No. 4,912,422).

36. Applicant submits that the above-recited data source (which is adapted to process a plurality of information symbols to generate a set of data symbols with a predetermined set of phase relationships and amplitude profiles to provide a superposition of the carriers with orthogonality in time) in independent claim 110 (and hence, in the dependent claim 135) not only presents novel structure, but provides new utility for multi-carrier signaling that the prior-art references neither describe nor anticipate. Thus, the independent claim 110 (and hence, the dependent claim 135) should be considered patentable under 35 U.S.C. 103.

The Novel Physical Feature of Claim 110 Provides New and Unexpected Results and Hence Should Be Considered Non-obvious, Making the Claim 110 Under 35 U.S.C. 103.

37. Specifically, by providing a plurality of data symbols with a predetermined set of phase relationships and amplitude profiles that provide a superposition of the carriers with orthogonality in time, each data symbol is spread over the carriers (thus providing frequency diversity) and the data symbols are mapped to orthogonal pulse waveforms (thus providing optimal bandwidth efficiency). This enables the following improvements over prior-art multicarrier systems:

- The multi-carrier signals of the present invention can mimic single-carrier signals, such as direct sequence and time division multiple access signals.
- The set of multicarrier signals of the present invention can be received and processed as if it were a single-carrier signal, making the invention backwards compatible with existing single-carrier systems.
- The present invention can provide the enhanced performance (e.g., lower bit error rate, lower susceptibility to interference, improved robustness to multipath) of multi-carrier processing to single-carrier signaling.

Therefore, Applicant submits that the above-recited novel features in the independent claim 110, and hence in the dependent claim 135, provide new and unexpected results and therefore should be considered non-obvious, making the claims patentable under 35 U.S.C. 103.

38. None of the prior-art multi-carrier communication systems can provide these New and Unexpected results.

39. Neither Hershey nor Kobayashi, nor any combination of Hershey and Kobayashi, can provide these new and unexpected benefits.

Hershey describes GHM in which preamble and traffic waveforms are created from multiple carrier frequencies (i.e., tones) that are geometric harmonics of a fundamental tone. The preamble waveforms in GHM do not carry data. Therefore, the preamble waveforms do not produce a superposition of the carriers with orthogonality in time (i.e., pulse waveforms) based on data. Furthermore, GHM employs binary-phase codes, which also prevent the generation of pulse waveforms that are orthogonal in time. The traffic waveforms in GHM are products, rather than sums, of coded tones. Therefore, the traffic waveforms do not produce carrier superpositions nor orthogonal pulse waveforms. This is illustrated in FIGs. 1a, 1b, and 1c in '906, which shows that the resulting waveforms are not orthogonal pulse waveforms.

Kobayashi teaches time domain to frequency domain processing for a **single-carrier** signal, followed by frequency domain to time domain processing. Kobayashi does not disclose any method for processing a **multi-carrier** signal in this manner. Kobayashi does not teach to generate a superposition of carriers with orthogonality in time.

The combination of Hershey and Kobayashi is incapable of providing a superposition of carriers with orthogonality in time. In particular the application of time domain to frequency domain processing and/or frequency domain to time domain processing (which is typically implemented with a Fourier transform algorithm) to Hershey's preamble or traffic waveforms cannot generate a set of data symbols with a predetermined set of phase relationships and amplitude profiles that provide a superposition of the carriers with orthogonality in time, such as recited in Claim 110.

40. Because the novel physical features of Applicant's device provide these new and unexpected results over any reference, and the addition of Applicant's device to the prior-art devices of the cited and applied references results in a substantial improvement in the performance of these prior-art devices, Applicant submits that these new results indicate non-obviousness of the novel physical features and hence, patentability. Accordingly, Applicant respectfully requests reconsideration and allowance of the present application with the above claims.

41. In addition to the above new and unexpected results, Applicant submits that additional reasons militate in favor of patentability, as follows:

42. **The prior-art teaches away from the suggested combination by implication.** The prior art teaches against the combination of Kobayashi with Hershey. The nature of prior-art multicarrier signals, including GHM signals described in Hershey, makes it impractical to apply Kobayashi to multicarrier processing. This is because in prior-art multicarrier signals, data symbols are not mapped to instants in time. Rather, superposition pulses resulting from prior-art multicarrier signals comprise interfering data symbols at instants in time, such as illustrated and described in Applicant's U.S. Pat. No. 5,955,992, of which the present application is a Continuation in Part. Thus, it would not be appropriate to process prior-art multicarrier signals in the time domain, such as in the manner disclosed in Kobayashi.

43. **One of the cited and relied-upon prior-art references teaches away from the claimed invention by implication.** In particular, FIG. 1c in Hershey illustrates how the dynamic range of a single user's transmit signal is high, whereas FIG. 7 illustrates how the relative dynamic range of many users' randomly chosen signals is smaller. This is important because it is well known in the art to minimize the dynamic range of the transmit signal in order to provide lower power back-off for power amplifiers, which reduces power consumption and non-linear distortion. Consequently, the prior art teaches against generating in-phase signals that combine constructively to produce pulses. For example, FIG. 7 in Hershey represents "users picking waveforms

randomly." Conversely, Applicants invention deliberately generates pulses from superpositions of carriers. However, since these pulses are orthogonal in time, a sequence of these pulses is characterized by a low dynamic range. Thus, the present invention achieves signals having a low dynamic range, which is a well known desirable objective in the prior art, by employing a technique that is taught against by the prior art.

44. **Unrecognized problem.** The cited art describes different types of signal processing to that claimed by the present invention. Although different to the present invention, such protocols have use, as is evidenced by the teaching of the prior art. Such use is served by the Hershey and Kobayashi protocols and there is no teaching in the prior art to change the type of communication protocol provided so as to resemble or reflect that of the present invention. As there is no motivation to change, no teaching to change, and no description of how any change may be made to produce a CIMA protocol, it is submitted that the presently claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

The Cited but Non-Applied References

45. These subsidiary references have been studied, but are submitted to be less relevant than the relied-upon references.

46. Conclusion

The Applicant submits that every effort has been made to address the Examiner's objections and that the Application is now in condition to proceed to grant.

Yours Respectfully,

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